

LEVEL 4 ASSESSMENT SPECIFICATION

Student name:	Matthew lane	Student ID number:	2103505
Programme:	BEng Motorsport/Automotive Engineering		
Module:	Motorcycle/Motorsport/Vehicle Technology		
Module code:	ACHA4003/4004/4012	Contribution to Overall Module Assessment (%):	50
Lecturer:	Ryan James	Internal Verifier:	Andrew Noble
Assignment Title:	Engine Performance Characteristics	Word count (or equivalent):	1500
Submission deadline:	28/03/2022	Return date of provisional marks & written feedback:	20 Term Time Days from Submission
Submission method:	All written assessments, where practical and possible, must be submitted via Turnitin unless otherwise instructed by the Lecturer. (Please DO NOT put this assessment specification into Turnitin or it will match many similarities with other students' submissions.) Alternative submission method (if applicable): Late submission of the assessment will result in a late penalty mark. Penalties for late submission: Up to one week late, maximum mark of 40%. Over one week late, 0%. Only the Extenuating Circumstances Panel may approve a change to submission dates.		
Academic honesty / referencing:	Academic honesty is required. In the main body of your submission you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

Module Learning Outcomes (from module syllabus)

- Show a detailed knowledge and understanding of the underlying principles of **engine** and vehicle technologies and practices for analysis of powertrain and chassis systems
- demonstrate subject specific practical skills applied to an automotive problem, obtaining and interpreting data in a laboratory environment and drawing relevant conclusions
- show cognitive skills with respect to simplification and modelling of real automotive problems, the application of fundamental mechanical engineering principles and the analysis of problems and making recommendations on findings

TASK DESCRIPTION

Each student is to view the videos of the engine tests, which are like those that would have been used to collect the data provided, and then evaluate the results by completing the associated Matlab Live Script calculations, finding values for the primary variables in question. The results generated from the Matlab script will be used in the written report to inform and support the discussions of the engine operating parameters.

Activities:

You are provided with a Matlab Live Script which contains guidance on the various steps that are required to complete the calculations. Please ensure that you follow the live script closely, this will ensure that you calculate the correct information, along with plotting the correct graphs which will aid in your written report.

GUIDANCE FOR STUDENTS IN THE COMPLETION OF TASKS

Engine Performance Testing and Analysis on the Honda engine:

1. View the dyno testing videos 1. <https://youtu.be/-WajOAp2LUE> 2. <https://youtu.be/VD9OPoaAcJU>
2. Complete the calculations and data plots using the Matlab Live Script. Use the formula sheet that you have been provided to help you with the formula construction required in the script.

Written Report:

1. Write a concise introduction that discusses the use and potential benefits of engine dynamometer testing. Aims and objectives of the investigation should also be included as a sub-section of the introduction. Ensure there is literature informed discussion in this section.
2. Briefly describe the testing equipment and method used, based on the videos you have been provided.
3. Using the calculations you have performed in Matlab, supported by the graphical data you have generated, discuss the suggested topic areas in the table below. These are suggested areas of discussion, you are free to go deeper into the data and discuss further areas of interest. Be sure to use literature and comparative data from sources in your discussion of these areas.
4. Draw conclusions from your results. This section should be concise but draw on the key data from the results you have observed and the importance of these factors. Also, attempt to highlight the limitations of the testing methods and calculations that you have used during your investigation, to critically evaluate the work completed.

Graph to be Plotted	Associated Question
SFC heat map against load and engine speed	Suggest reasons why the SFC varies as it does with engine speed and load.
Double Y axis graph of Torque and Power against engine speed, at full load	Suggest reasons why Torque and Power vary as they do with engine speed.
Double Y axis graph of Thermal Efficiency and BMEP at Full Load	Suggest reasons why Thermal Efficiency and BMEP vary as they do with engine speed.
3D Plot of cylinder Pressures across all RPM's and Crank Angles.	Discuss the differences and importance of values found in the different engine operating strokes.

GUIDANCE FOR STUDENTS IN THE COMPLETION OF TASKS

NOTE: The guidance offered below is linked to the five generic assessment criteria overleaf.

1. Engagement with Literature Skills

Your work must be informed and supported by scholarly material that is *relevant* to and *focused* on the task(s) set. You should provide evidence that you have accessed an appropriate *range* of sources, which may be academic, governmental and industrial; these sources may include academic journal articles, textbooks, current news articles, organisational documents, and websites. You should consider the *credibility* of your sources; academic journals are normally highly credible sources while websites require careful consideration/selection and should be used sparingly. Any sources you use should be current and up-to-date, mostly published within the last five years or so, though seminal/important works in the field may be older. You must provide *evidence* of your research/own reading throughout your work, using a suitable referencing system, including in-text citations in the main body of your work and a reference list at the end of your work.

2. Knowledge and Understanding Skills

At level 4, you should be able to demonstrate knowledge of the underlying concepts and principles associated with your area(s) of study. *Knowledge* relates to the facts, information and skills you have acquired through your learning. You demonstrate your *understanding* by interpreting the meaning of the facts and information (knowledge). This means that you need to select and include in your work the concepts, techniques, models, theories, etc. appropriate to the task(s) set. You should be able to explain the theories, concepts, etc. to show your understanding. Your mark/grade will also depend upon the *extent* to which you demonstrate your knowledge and understanding.

3. Cognitive and Intellectual Skills

You should be able to present, evaluate and interpret qualitative and quantitative data, in order to develop lines of argument and make sound judgements in accordance with basic theories and concepts of your subject(s) of study. You should be able to evaluate the appropriateness of different approaches to solving problems related to your area(s) of study and/or work. Your work must contain evidence of logical, analytical thinking. For example, to examine and break information down into parts, make inferences, compile, compare and contrast information. This means not just describing what! But also justifying: Why? How? When? Who? Where? At what cost? You should provide justification for your arguments and judgements using evidence that you have reflected upon the ideas of others within the subject area and that you are able to make sound judgements and arguments using data and concepts. Where relevant, alternative solutions and recommendations may be proposed.

4. Practical Skills

At level 4, you should be able to apply the basic underlying concepts and principles to evaluate and interpret these within the context of your area of study. You should be able to demonstrate how the subject-related concepts and ideas relate to real world situations and/or a particular context. How do they work in practice? You will deploy models, methods, techniques, and/or theories, in that context, to assess current situations,

perhaps to formulate plans or solutions to solve problems, or to create artefacts. This is likely to involve, for instance, the use of real world artefacts, examples and cases, the application of a model within an organisation and/or benchmarking one theory or organisation against others based on stated criteria.

5. Transferable Skills for Life and Professional Practice

Your work must provide evidence of the qualities and transferable skills necessary for employment requiring the exercise of some personal responsibility. This includes demonstrating that you can communicate the results of your study/work accurately and reliably, and with structured and coherent arguments; that you can initiate and complete tasks and procedures, whether individually and/or collaboratively; fluency of expression; clarity and effectiveness in presentation and organisation. Work should be coherent and well-structured in presentation and organisation.

STUDENT FEEDBACK FORM

This section details the *extent* to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills		
Inclusion of external information [6 marks] Properly cited references [5 marks] Quality of references [4 marks]	15	
2. Knowledge and Understanding Skills		
Discussion of the principles underpinning the work being undertaken. This may relate to the operation of engine dynamometer testing, the physics behind the calculations and the impact the results have on real world engine performance.	10	
3. Cognitive and Intellectual Skills		
Related to the quality of the discussion sections of the report where you analyse the data you have calculated in the Matlab script. For higher marks, you should attempt to be critical in your analysis of the data where possible. Remember, not all data and testing is perfect, so there are likely areas of the results that you can find issue with. It is also advisable to find sources that have done similar testing and use their results to compare to your own, this can be a good way of supporting the discussion you are making.	25	
4. Practical Application Skills		
Marks awarded to the accuracy and quality of the code written in the Matlab live script that is submitted	40	
5. Transferable Skills for Life and Professional Practice		
Quality of written report. Ensure that you adhere to the report writing guidelines templates and documents you have been issued.	10	

	Late Submission Penalties (tick if appropriate)	%
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Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)

Up to 1 week late (40% Max)	
Over 1 week late (0%)	

GENERIC ASSESSMENT CRITERIA

Level 4

In accordance with the Framework for Higher Education Qualifications, at the end of Level 4 students will be expected to have demonstrated underlying concepts and principles of a subject, and an ability to evaluate and interpret these within the context of that area of study. They should be able to evaluate and interpret qualitative and quantitative data in order to develop lines of argument and make sound judgements in accordance with their subject(s) of study. They will have learned how to evaluate different approaches to solving problems, and will be able to communicate accurately and reliably, and with structured and coherent arguments. They will be able to undertake further training and develop new skills within the environment and will have the qualities and transferable skills necessary for employment requiring the exercise of some personal responsibility.

Level 4	FAIL	MARGINAL FAIL	SATISFACTORY (3 rd / Pass)	GOOD (2.2 / Pass)	VERY GOOD (2.1 / Merit)	EXCELLENT (1 st / Distinction)
Category	0-29%	30-39%	40-49%	50-59%	60-69%	70-79%
Engagement with literature (including reading, referencing, academic conventions and academic honesty)	Little or no evidence of reading and/or reliance on inappropriate sources. Views and findings mostly unsupported and nonauthoritative. Referencing conventions used incoherently or largely absent.	Poor engagement with essential reading. No evidence of wider reading. Reliance on inappropriate sources, and/or indiscriminate use of sources. Heavily reliant on information gained through class contact. Inconsistent and weak use of referencing.	Engagement with a limited range of mostly relevant and credible sources but with some reliance on information gained through class contact. Some omissions and minor errors. Referencing conventions evident though not always applied accurately or consistently.	Engagement with an appropriate range of literature, including sources retrieved independently. Some over-reliance on texts rather than other sources. Referencing may show minor inaccuracies or inconsistencies.	Engagement with a wide range of literature, including sources retrieved independently. Selection of relevant and credible sources. Generally sound referencing, with no/very few inaccuracies or inconsistencies.	Engagement with an extensive range of relevant and credible literature. Consistent and accurate application of referencing.
Knowledge and understanding (Knowledge of the basic underlying concepts and principles of a subject.)	Major gaps in knowledge and understanding of the basic underlying concepts and principles of the subject matter. Inclusion of irrelevant	Gaps in knowledge of the basic underlying concepts and principles, with flawed or superficial understanding. Some significant inaccuracies	Limited knowledge and understanding of the basic underlying concepts and principles within the subject area.	Knowledge of the basic underlying concepts and principles is accurate with a good understanding of the field of study	Competent knowledge of the basic underlying concepts and principles. Exhibits very good understanding.	Excellent knowledge and understanding of the basic underlying concepts and principles of the subject.

Level 4	FAIL	MARGINAL FAIL	SATISFACTORY (3 rd / Pass)	GOOD (2.2 / Pass)	VERY GOOD (2.1 / Merit)	EXCELLENT (1 st / Distinction)
Category	0-29%	30-39%	40-49%	50-59%	60-69%	70-79%
	material. Substantial inaccuracies.	and/or irrelevant material.	Some elements may be missing.	but lacks depth and/or breadth.		

Cognitive and intellectual skills (Evaluate underlying concepts and principles of a subject and interpret qualitative and quantitative data in order to develop lines of argument and make sound judgements.)	Wholly or almost wholly descriptive work. Little or no evaluation of the underlying concepts and principles. Failure to develop arguments, leading to illogical or invalid judgements. Minimal or no use of evidence to back up views.	Largely descriptive work, with superficial evaluation of the underlying concepts and principles. Weak interpretation of data, flawed development of arguments and judgements. Information accepted uncritically, uses generalised statements made with scant evidence and unsubstantiated opinions. Ideas sometimes illogical and contradictory.	Limited attempt at evaluation of the underlying concepts and principles, tending towards description. Can interpret qualitative and quantitative data but with some errors. Some evidence to support emerging arguments and judgements but these may be underdeveloped or with a little inconsistency / misinterpretation.	Good evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative data, with minor errors. An emerging ability to use evidence to support the argument. Mostly valid arguments and logical judgements.	Sound evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative data accurately. Ability to devise arguments using evidence to make mostly appropriate and valid judgements.	Excellent evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative data accurately with sound evidence. Excellent ability to devise arguments using evidence to make appropriate and valid judgements.
Practical skills (Different approaches to solving problems in particular contexts.)	Limited or no use of taught, basic methods, materials, tools and/or techniques. Little or no appreciation of the context of the application. Very weak evidence of different approaches to	Rudimentary application of taught, basic methods, materials, tools and/or techniques but without consideration and competence. Flawed appreciation of	An adequate awareness and mostly appropriate application of basic methods, materials, tools and/or techniques. Basic appreciation of the context of the application.	A good and appropriate application of basic methods, materials, tools and/or techniques. Clear appreciation of the context of the application. Good evidence of different approaches to	A very good application of a range of basic methods, materials, tools and/or techniques. Very good consideration of the context of the application. Very good evidence of different	An advanced application of a range of basic methods, materials, tools and/or techniques. Very good consideration of the context of the application. Well considered and insightful evidence of different
Level 4	FAIL	MARGINAL FAIL	SATISFACTORY (3rd / Pass)	GOOD (2.2 / Pass)	VERY GOOD (2.1 / Merit)	EXCELLENT (1st / Distinction)
Category	0-29%	30-39%	40-49%	50-59%	60-69%	70-79%
	problem-solving in particular contexts.	the context of the application. Weak evidence of different approaches to problem-solving in particular contexts.	Can identify problems in particular contexts and propose basic alternative approaches or solutions though there may be errors.	problem-solving in particular contexts and proposes mostly appropriate solutions.	approaches to problem-solving in particular contexts and proposes appropriate solutions.	approaches to problem-solving in particular contexts and proposes appropriate solutions.

Transferable skills for life and professional practice (Communicate the results of their study/work accurately and reliably, and with structured and coherent arguments; the qualities needed for employment requiring the exercise of some personal responsibility within a structured and managed environment.)	Work is poorly structured, disorganised, inaccurate and/or confusingly expressed. Very weak use of language and/or very inappropriate style. Failure to work effectively individual or as part of a group. Little or no evidence of the skills for employment requiring the exercise of some personal responsibility.	Work is poorly presented in a disjointed manner. It is loosely, and at times incoherently, structured, with information and ideas often poorly expressed. Weak use of language and/or inappropriate style. Flawed approach to individual or group work, meeting only partial obligations to others. Limited evidence of the skills for employment requiring the exercise of some personal responsibility.	Mostly ordered presentation and structure in which relevant ideas / concepts are reasonably expressed. Work may lack coherence and/or accuracy in places. Can work as part of a group, meeting most obligations to others but perhaps with limited involvement in group activities. Demonstrates the basic skills for employment requiring the exercise of some personal responsibility, with some areas of minor weakness.	Mostly coherent, organised and accurate work, in a suitable structure and is for the most part clearly expressed. Can work effectively independently and/or as part of a team, with clear contribution to group activities. Demonstrates the skills for employment requiring the exercise of some personal responsibility, with some areas of strength and some of minor weakness.	Work is accurate, coherent, fluent, well-structured and organised. Can work effectively independently and/or as part of a team, with very good contribution to group activities. Demonstrates very good skills for employment requiring the exercise of some personal responsibility, with just occasional minor weakness.	Work is coherent, fluent and well-presented. Can work effectively independently and/or as part of a team, with excellent contribution to group activities. Demonstrates excellent skills for employment requiring the exercise of some personal responsibility, with an ability to develop further.
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Introduction

The following report will cover the use, testing and the analysis of data collected from a dynamometer. A dynamometer is a piece of equipment that allows the user to take readings for mechanical forces and power transmitted that is being displayed by the engine. The benefits of using a dynamometer to collect data are as follows, it reduces the risk of damage to equipment, ensures safety, allows the user to gain data accurately and efficiently and allows to gain a variety of data from the use of one machine. The data collected will be used in a software called MATLAB to calculate results and produce graphs.

Equipment and function

The dynamometer is fitted directly to the engine via a drive bolted to the crank shaft and the dynamometer. There are multiple sensors attached at different points on the engine to take readings such as coolant temperatures, flow meter and a lambda sensor. The dynamometer itself is also fitted with sensors recording coolant temperature and speed, there can be over 2000 sensors fitted depending on what is needed to be found within the engine.

The readings are taken through the sensor recorder module that relays the information to the computers.

Also fitted to the setup is the exhaust extraction system and the fuel supply board, the supply board allows fuel to be pumped from the main tank via filter pump to the fuel flow meter it is then moved onto the secondary swirl point, then into the main pump that feeds the engine. This method allow testing on both fuel-injected and non-injected engines.

A return system allows fuel to be fed back through the system after passing through the cooling plate. When taking the reading for fuel flow it must be kept in mind that it only measures what in in the engine itself.

The engine will be self-contained with the basic functions being controlled by the sensor module and the main control unit.

When in use the dynamometer's inner core will spin freely and is powered by the engine, the outer casing is supplied with current using an electromagnetic field as it will try to turn but is restricted by a string gauge to slow the engine down.

When the string gauge is set off it will send a signal between 0-10 volts to the computer system through the control cell.

The system is celebrated using celebration arms which are located either side in order to neutralise each other. They are celebrated to specific lengths. Weight can be added to the calibration arms allowing torque to be calculated on the outer casing.

A limitation that can be identified with this system is that it will be producing large amounts of heat but is cooled by an inlet from the coolant allowing the temperature to always stay the same.

Testing

When testing there are two control dials. The first dial is for the engine, this will control the RPM. The second dial is for the dynamometer this will allow control the current being fed into dynamometer creating a magnetic field to slow the engine down by producing torque

There are three monitors in the control room, the left monitor, right monitor and the central monitor. The monitor on the left will display the torque gage, this will also show other diagnostics such as lambda and fuel flow rate along with other various numerical parameters. The monitor on the right will display the dynamometer speed while also displaying things like the coolant pump and ignition and again will also show a wide variety of numerical parameters. Finally, the central monitor will display the graph trends while the engine is running showing reading such as throttle and torque, with throttle reading between 1%-100% and torque having a value between 0%-200%

There are two types of tests that can be carried out, these are show scope and P-cure tests. Firstly, show scope testing is a step-by-step system that requires a test manager. The role of the test manager will insert different parameters depending on how the engine is required to run. Some of the requirements could be things like a loop or even programming specific command that can be added in the sequence.

The P-curve has two different procedures there is a step test and a sweep test. The step test is for targeting specifics this can be things such as emissions, lambda and fuel flow. The test allows graph and data to be displayed accurately at the end of the test, this is achieved by setting a starting RPM and a finish RPM while being able to set pauses and time constraints. When the cycle finishes the dynamometer will control the speed and measuring the force applied. The graph developed from this test will show power, engine speed, force applied and torque.

The advantage to using this procedure is that's its very accurate and allows the sensors enough time to get a good reading. A downside to this test is that puts large amounts of strain on the engine this is due to the engine being held at certain RPM range with the throttle open.

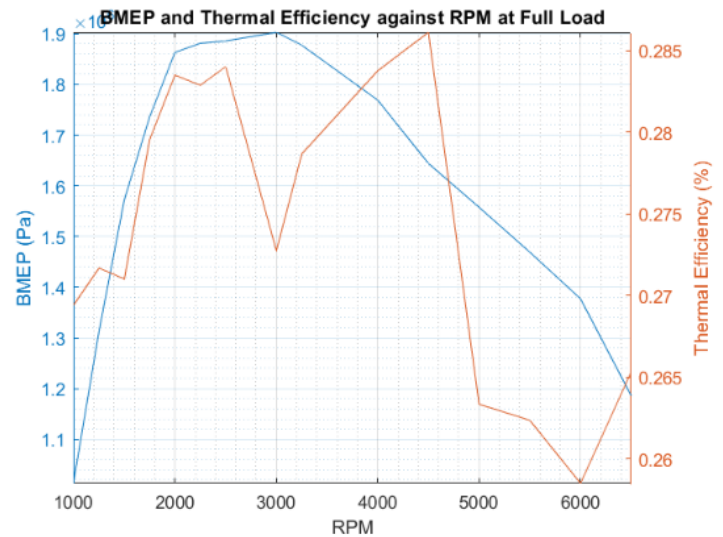
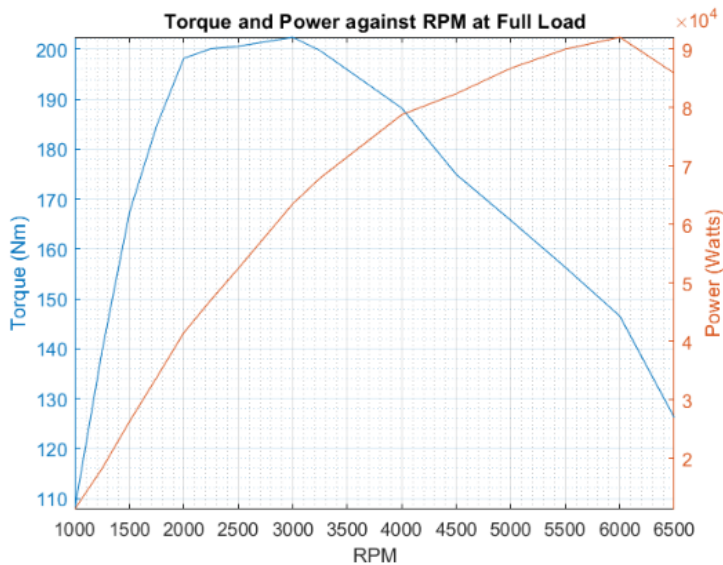
The second type of P-cure test is the sweep test. The sweep test allows a high volume of data to be recorded, the data consists of fuel flow rate and lambda. The test is conducted quick, this is due to having a set start and finish time but with no pauses to allow for reading to be taking as accurate as they could have been, but due to the quick time it allows the engine to not overheat.

Results

Below are some of the results gained from the MATLAB software.

The graph to the left is showing torque and power against load.

The graph on the right shows BMEP and Thermal Efficiency against RPM at full load



The above graphs demonstrate that when the throttle increased the RPM rises. Subsequently this increases the torque as it tries to slow the engine down. From the results it shows that when the load increases the RMP drops and when the load is taken off the RMP will climb back up increasing in a direct correlation as the engine is allowed to run freely.

When the engine is producing power, the torque will increase. This results in the engine being able to overcome the dynamometer as it produces more horsepower. When the torque load is removed the RPM will increase and the horsepower needed to overcome the force drops.

The BMEP shows that at the lower RPM range it was able to climb but deteriorated just over 3000RPM and started to drop down same as the thermal efficiency this is due to the engine having to work harder due to increasing the temperatures from the engine.

Conclusion

From the selected test it was easy to gain vast amount of data, being able to do this allows for better evaluation and comparisons to find out what is happening within the engine. The tests did have some small limitations. These limitations were temperatures, strain on the engine and some not so accurate data. The use of MATLAB to produce graph helps to show clear differences and highlight what was happening in the engine at specific moments.

References

<https://ceypetco.gov.lk/95octane/>

https://www.engineeringtoolbox.com/fuels-higher-calorific-values-d_169.html

[.https://youtu.be/-WajOAp2LUE](https://youtu.be/-WajOAp2LUE)

<https://youtu.be/VD9OPoaAcJU>